

## THE VIKING BIOLOGY RESULTS

Harold P. Klein  
Department of Biology  
Santa Clara University SC188052  
Santa Clara, CA 94303

A brief review of the purposes and the results from the Viking Biology experiments is presented here, in the expectation that the lessons learned from this mission will be useful in planning future approaches to the biological exploration of Mars. Considerable discussion, prior to the selection of the final Biology instrument payload, resulted in the conclusion that a single concept would not be adequate, since so little was then known about potential micro-environments on Mars. This resulted in the final inclusion of three different experiments in the Viking mission, each one based on different assumptions about what Martian organisms might be like. In addition to the Viking Biology Instrument (VBI), important corollary information was to be obtained from the Viking lander imaging system and from the molecular analysis experiments that were to be conducted using the Gas Chromatograph-Mass Spectrometer (GCMS) instrument.

After examining upwards of 5,000 pictures from the lander imaging instrument, no "biological" objects were noted at the lander sites; no color changes, attributable to living organisms were seen; and—aside from nominal changes due to weather—no objects were observed to move into or out of the fields of view.

The GCMS instrument, which could detect organic compounds down to a few parts per billion (for molecules containing three or more carbon atoms) and down to a few parts per million (for smaller organics), did not detect any organic compounds.

The VBI consisted of three basic experimental components packaged into a volume of about 1 ft<sup>3</sup> and weighing about 35 lbs. Using all of the experimental modes, it was possible to incubate Martian "soil" (in the dark or with simulated solar illumination; wet, dry, or with a humid atmosphere; and with and without added nutrients) for periods of up to several months. In all, 26 experiments were conducted at the two sites. To distinguish between biological and non-biological signals, in some experiments, the "soil" was heated to "sterilizing" temperatures (145° to 175° C) prior to incubation.

The Gas Exchange experiment (GEX) measured gas changes in the headspace of the incubation chamber containing Martian "soil" samples. In the "humid" mode of the GEX, the samples were incubated without nutrients, but in a humid atmosphere. This experiment, which was performed three times, showed a very rapid evolution of oxygen upon humidification. Furthermore, the reaction, which was stable to sterilization and to storage at spacecraft temperatures for about 5 months, appears to be inversely correlated with the water content of the samples. Subsequent contact of the samples with a nutrient solution consisting of a rich aqueous mixture of organic compounds did not result in the evolution or uptake of gases beyond that expected from non-biological processes (desorption of atmospheric gases; reactions between the atmospheric components and nutrients).

In the Labeled Release (LR) experiment, soil samples were incubated with a dilute aqueous solution of simple organic compounds labeled with <sup>14</sup>C and the headspace monitored for the release of labeled

CO<sub>2</sub>. Each time samples were tested by the LR experiment, there was a rapid release of labeled gas (amounting to about 10–15% of the added counts), followed by a period during which labeled gas continued to be released at a very slow rate for up to several weeks. The rapid evolution of label was abolished by sterilization temperatures; was reduced by about 70% by prior heating at about 45° C; and was lost upon storage at spacecraft temperatures.

The Pyrolytic Release (PR) experiment tested for the uptake of either <sup>14</sup>CO or <sup>14</sup>CO<sub>2</sub> into organic matter during incubation of samples in the light or in the dark. Weak “positives” were obtained—indicative of the fixation into organics of one or the other of the added compounds—seven of the nine times that the PR was performed, including one in which the sample had first been heated to 90° C. Taken as a whole, the Viking data yielded no unequivocal evidence for a Martian biota at either landing site. The results also revealed the presence of one or more reactive oxidants in the surface material and these need to be further characterized, as does the range of micro-environments, before embarking upon future searches for extant life on Mars.